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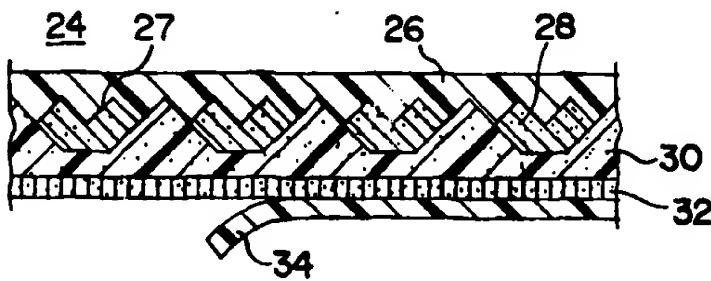
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(54) Title: PHOTOLUMINESCENT RETROREFLECTIVE SHEETING



(57) Abstract

A photoluminescent retroreflective sheeting (24) for use in structures when a power outage occurs. Guidance systems are made from this sheeting to mark exits and escape routes as well as possible hazards and safety devices. The novel sheeting (24) includes photoluminescent properties that glow in the dark as well as retroreflective properties that retroreflect light incident upon the same sheet (24) such that only one sheet has to be used rather than individual sheets with separate properties.

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DESCRIPTION

PHOTOLUMINESCENT RETROREFLECTIVE SHEETING

This is a continuation-in-part of United States Serial Number 821,207, filed January 16, 1992.

5 TECHNICAL FIELD

The invention relates generally to a photoluminescent retroreflective sheet material for use as a guide marker and which has particular utility in buildings when a power outage occurs. Specifically, the 10 present invention relates to a photoluminescent retroreflective sheeting combining both photoluminescent and retroreflective properties in a single product to be used to form a marker system to help indicate exits, doorways, hazards, OSHA markings, pipe markings, high 15 voltage areas, fire hoses and extinguishers and the like, when it is dark in the building, perhaps when caused by a power outage.

BACKGROUND ART

The term "building" as used throughout this 20 application is intended to include any structure such as an aircraft, boat or other moveable and non-moveable conventional structures.

It is well known that within buildings at night or especially when the power has been lost, it is difficult 25 to find ones way along the necessary corridors to the building exits. Similarly, in some emergencies, the location of important fixtures such as fire alarms, extinguishers, shut-off valves and the like are difficult to find.

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In the prior art, a photoluminescent material is utilized as a guide for such purposes. The luminous material is attached to doorways, hallways, and the like, so that in the event of a power outage, the 5 photoluminescent material will glow in the dark and guide a person to an exit or along a prescribed path. Of course, it is only useful to those individuals in the building that have adjusted their eyes to the darkness. Further, the luminescence produced is significantly lost 10 within the first 20 minutes of an "outage." This makes it virtually useless to anyone entering the building after a short period of time.

The present invention overcomes the disadvantages of the prior art by providing a single sheeting material 15 having both photoluminescent and retroreflective properties. The sheeting should exhibit the same photoluminescent properties as the current product being used, and it has significant retroreflective properties.

Thus it is an important object of the present 20 invention to provide a photoluminescent retroreflective sheet material that is designed to provide both photoluminescence and retroreflection of light.

It is also an object of the present invention to provide a photoluminescent retroreflective sheeting in 25 which a phosphorescent pigment is added to the retroreflective layer.

It is a further object of the present invention to provide a photoluminescent retroreflective sheet in which the retroreflective layer has cube corner retroreflectors 30 embossed on the backside thereof and covered by a predetermined pattern of hydrophobic silica. A backcoating contains the phosphorescent pigment and is in contact with the retroreflective layer in areas of the

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pattern not covered by the hydrophobic silica.

It is yet another object of the present invention to provide a photoluminescent reflective sheet which has a transparent flexible film with retroreflective cube 5 corners formed on the reverse surface thereof and a clear adhesive with phosphorescent pigment screen-printed in a pattern and cured on the cube corners.

It is believed that the present invention may be utilized with retroreflector sheeting produced in a 10 variety of ways but will be particularly useful with that retroreflective sheeting described and claimed in U.S. Patent No. 4,618,518, issued October 21, 1986, to Robert M. Pricone, et al. and assigned to applicants' assignee, the disclosure of which is incorporated by 15 reference. Other forms and methods of producing retroreflective sheeting include those of "casting" cube corner elements, such as disclosed in Rowland U.S. Patents 3,810,804, issued May 14, 1974; 3,684,348, issued August 15, 1972; and 3,689,346, issued September 15, 20 1972.

Useful apparatus for embossing a film to provide cube corner retroreflective elements is disclosed in Pricone, et al. U.S. 4,601,861, issued July 22, 1986, commonly assigned. Other techniques for compression or 25 sequential embossing are disclosed in Rowland U.S. 4,244,683, dated January 13, 1981.

Efforts have been made in the past to utilize fluorescent pigmented materials in conjunction with retroreflective sheet materials of the cube corner type. 30 However, such use of fluorescent materials was intended to provide a combination of day/night visibility in highway signs. One example is that found in Rowland U.S. Patent 3,830,682, issued August 20, 1974. However, in

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such uses, unlike phosphors, the fluorescent material would not continue to glow or provide light under "darkened" conditions but instead is illuminated by the light of certain wave lengths, so as to provide some 5 "daylight" visibility to highway signs.

The present invention utilizes a phosphorescent pigmentation in conjunction with retroreflective sheet material in a manner which does not materially impede the retroreflective capability of the sign when illuminated 10 either under normal lighting conditions, such as in a building and under hallway lighting lights, nor does it impede the "dark" or night light retroreflective capability when illuminated by a flashlight or other temporary light source.

15 DISCLOSURE OF THE INVENTION

The present invention relates to a photoluminescent retroreflective sheeting material, which, in one embodiment, comprises a first layer of transparent retroreflective film having a front face and a plurality 20 of cube corner retroreflective elements formed on at least a portion of the reverse or rear face to retroreflect light impinging upon the front face; a second layer of clear adhesive is screen-printed in a pattern and cured on the formed cube corner elements; a 25 third layer of opaque film is adhered to the second layer to form air cells; an adhesive fourth layer is applied to the third layer for attaching the sheet material to a substrate surface; and a release liner is normally secured to the adhesive layer to prevent inadvertent 30 contact of the adhesive layer with a surface. A phosphorescent pigment is contained in at least one of the first, second, third or fourth layers to cause the

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sheet to glow in the dark.

In a second embodiment the second layer is comprised of hydrophobic silica which eliminates the "air cell".

In a third embodiment, a thermoplastic film is attached to the reverse side of the transparent retroreflective film by heat sealing or sonic welding. This second film can be photoluminescent film which has secured to it a separate white adhesive layer, or can be comprised of two layers, a photoluminescent layer and an opaque white layer, followed by an adhesive layer. Other embodiments are disclosed.

#### BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects of the present invention will be more fully understood when taken in conjunction with the following detailed description and the attached drawings in which like numerals represent like elements and in which:

FIG. 1 is a first embodiment that illustrates a cross sectional view of photoluminescent retroreflective sheeting of the present invention in which clear adhesive with a phosphorescent pigment is screen printed in a pattern on the retroreflective cube corners formed on the rear surface of a transparent film;

FIG. 2 is a cross-sectional view of a second embodiment of the present invention in which the retroreflective layer of film has the cube corners embossed on the rear surface thereof and a hydrophobic silica pattern is applied on the embossed surfaces; a backcoating with phosphorescent pigment is applied over the hydrophobic silica and is in contact with the otherwise exposed retroreflective cube corner elements;

FIG. 3 is a cross-sectional view of a third

embodiment of the present invention in which the retroreflective layer has the cube corner reflectors on one side thereof and which layer also contains the phosphorescent pigment for enabling the sheet to be seen 5 when not illuminated by an external source. An adhesive layer is applied over the hydrophobic silica layer and exposed cube corner elements, and a release liner is added to prevent accidental contact of the adhesive with a substrate surface;

10 FIG. 4 is a cross-sectional view of yet another embodiment of the present invention, in which the retroreflective layer contains the phosphorescent pigment; the hydrophobic silica is screened in a pattern over the embossed cube corner retroreflectors on the 15 retroreflective layer; a white backcoating is applied to the silica layer and to the exposed cube corner elements, an adhesive layer is added and a release liner is applied to prevent the adhesive from accidentally touching a surface;

20 FIG. 5 is a schematic drawing of a process for making one embodiment of the present invention;

FIG. 6 is a schematic drawing of the process for making the invention illustrated in FIG. 2 of the present invention;

25 FIG. 7 is a schematic drawing of the process for making the embodiment of FIG. 3 of the drawings;

FIG. 8 is a schematic drawing of the process for making the photoluminescent retroreflective sheeting of the FIG. 4 embodiment; FIG. 9 is a cross-sectional view 30 of another embodiment of the invention in which the phosphorescent pigment is utilized with "beaded sheeting" containing microspheres to provide retroreflectivity;

FIG. 10 is a cross-sectional view of yet another

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embodiment of the invention in which a phosphorescent film is attached to the reverse side of the transparent film.

FIG. 11 is a cross-sectional view of a variation of 5 the embodiment of the invention shown in FIG. 10, with second film having a top photoluminescent layer and lower opaque white layer. FIG. 12 is a schematic drawing of the process of making the photoluminescent retroreflective sheeting embodiments shown in FIG. 10 and 10 FIG. 11.

#### DETAILED DESCRIPTION OF THE DRAWINGS

A preferred embodiment of the present photoluminescent retroreflective sheeting is illustrated in cross-section in FIG. 1. The sheet comprises a first 15 layer of transparent retroreflective film 12 that is formed generally in accordance with the method and apparatus disclosed in the aforesaid Pricone U.S. patent No. 4,486,363. However, as noted, other methods of forming a film with cube corner retroreflector elements 20 (or spherical retroreflectors) may be used.

In the preferred form, the film 12 is approximately 0.006-0.008 inches thick and has a plurality of retroreflective corner cube elements 13 embossed on the rear side thereof.

25 It also has a layer of clear adhesive 14 containing a phosphorescent pigment screened in a pre-selected pattern over certain of the cube corner elements 13 so as to leave spaces or cells 22. One such adhesive 14 may be that known as Flexcrill GP-2, sold by Air Products, Inc., 30 and applied by screen printing. This is a water based acrylic.

The adhesive 14 contains a phosphorescent pigment

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which may be of a type known as P-1000, sold by Hanovia, a division of Conrad, Inc. of Newark, N.J. and which is commercially available. Other phosphorescent pigments may be used. The pigment may be batch mixed with the 5 adhesive so as to constitute about 30% by weight thereof.

Other adhesives that may prove satisfactory would be drawn from unpigmented acrylics; urethanes; UV curable 100% solids; the criteria being that the adhesive bond between the resin layer and back layer be flexible and be 10 readily applied.

The transparent retroreflective film 12 with the clear adhesive 14 and containing the phosphorescent pigment therein is then cured by heating or, if appropriate, and if UV curable, then curing can be 15 accelerated.

After curing, an opaque layer of material 16, (such as polyester, PVC, or Mylar), is then applied over the transparent clear adhesive 14 with the phosphorescent pigment, to complete the "air" cells 22. The air cells 20 permit retroreflectivity to be achieved, as is known in the art. Preferably, this layer 16 will be of a white color to enhance the brightness of the phosphorescent effect, but other colors or metallized films may be used.

An adhesive fourth layer 18 then may be applied to 25 the white layer 16, enabling the sheeting material to be attached to a surface. A release liner 20 is applied to the adhesive layer 18 to prevent inadvertent contact of the adhesive with a surface until the user is ready to install the sheeting.

30 In the embodiment of FIG. 1, the retroreflective cells 22 allow the transparent film 12 to be retroreflective and reflect light impinging upon the front surface. The clear adhesive 14 with the

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phosphorescent pigment allows the strip to glow in the dark so that it can be followed by an individual. Thus, such sheeting can be used to form guidance systems that mark exits, doorways, hazards and the like in the case of 5 a power outage. When the photoluminescent property of the sheets fail then the retroreflective cube corner elements will retroreflect incident light, such as from a flashlight or the like carried by service individuals such as police, fire or utility department officials.

10 In FIG. 2, the sheeting 24 could be formed of a retroreflective layer of transparent flexible film 26 with cube corner retroreflective elements 27 formed on the reverse side thereof by embossing, to reflect incident light thereon. A hydrophobic silica layer 28 is 15 screen printed in a pattern over the cube corner retroreflective cells 27. A clear water-based backcoating 30 is then placed over the hydrophobic silica 28. The backcoating contains the phosphorescent pigment. A white pigment adhesive 32 is laminated to the 20 backcoating 30 for attaching the sheet to a surface. White pigment is used to enhance reflectivity as well as brightness of the phosphorescent material. A release liner 34 is laminated to the adhesive to prevent the adhesive 32 from inadvertently contacting a surface until 25 the user is ready.

In the embodiment illustrated in FIG. 3, the retroreflective layer 38 also includes the phosphorescent pigment therein. The hydrophobic silica 42 is then screened on the cube corners 40 in a 30 predetermined pattern and a white pigmented adhesive 44 is coated over the hydrophobic silica pattern. Again, a release liner 46 is laminated to the adhesive 44 to prevent the sheet from inadvertently sticking to a

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surface until the user is ready for it.

Other advantageous uses of the present invention with respect to retroreflective sheeting of other kinds, such as metallizing over some or all of the reflector 5 elements, also will be recognized. Thus, for example, retroreflective sheeting material is disclosed and Martin U.S. Patent 4,801,193 may be provided with the phosphorescent pigmentation advantageously employed in the present invention.

10 In the embodiment illustrated in FIG. 4, the sheet 48 is again formed of a transparent flexible film 50 that has retroreflective cube corner elements 52 formed on the reverse side thereof and which contains the phosphorescent pigment described earlier. Again, a 15 hydrophobic silica 54 is screened on the cube corners of the translucent reflective flexible film 50 in a predetermined pattern. A white backcoating 56 as described earlier is coated over the hydrophobic silica 54. An adhesive layer 58 is laminated to the white 20 backcoating 56 and a release liner 60 is laminated to the adhesive 58 to prevent the adhesive from inadvertently contacting a surface before the user desires.

The method of application and composition of the hydrophobic silica, backcoating and adhesive as discussed 25 herein may be as disclosed in the aforesaid Pricone et al., U.S. Patent No. 4,618,518.

A process for forming the photoluminescent retroreflective sheeting shown in FIG. 1 is illustrated in FIG. 5. The transparent flexible film may be extruded 30 and have retroreflective cube corner elements embossed or cast on the reverse side thereof at step 64. At step 68, a clear adhesive containing a phosphorescent pigment is screen printed in a predetermined pattern on the cube

corner elements on the reverse or rear side of the flexible film. At step 70, the adhesive is cured and at step 72 an opaque film, preferably white, is adhered to the adhesive to form air cells. At step 74, an adhesive 5 layer is added to the film and at step 76 a release layer is laminated to the adhesive layer to prevent the adhesive from adhering to a surface prior to the time it is needed.

Fig. 6 illustrates the process steps for forming the 10 invention of FIG. 2. Again, in step 1, the transparent flexible film is extruded. At step 80 retroreflective cube corners are formed on the reverse side by casting or embossing. At step 82, hydrophobic silica is screen printed in a pattern over the cube corner elements. At 15 step 84, the silica is coated with a clear water-based backcoating containing the phosphorescent pigment. A white (or other color) pigmented adhesive is applied to the silica coating at step 86 and a release layer is laminated to the pigmented adhesive at step 88 to prevent 20 the adhesive from inadvertently sticking to a surface.

FIG. 7 is a flow chart of the process for forming the photoluminescent retroreflective sheeting illustrated in FIG. 3. As can be seen in FIG. 7, the flexible film is extruded and contains the phosphorescent pigment which 25 glows in the dark. The retroreflective cube corner elements are then embossed on the reverse side of the extruded flexible film at step 92. Hydrophobic silica is then screen printed on the cube corners in a predetermined pattern at step 94. A water-based 30 backcoating adhesive is applied to the hydrophobic silica at step 96. Finally, a release liner is laminated to the adhesive at step 98 to prevent the product from sticking to a surface inadvertently.

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The flow chart of FIG. 8 discloses the method of making the sheeting sample illustrated in FIG. 4. Again, at step 100, the flexible film containing the phosphorescent pigment is extruded. In step 102 the 5 reverse side of the sheet is embossed with the cube corner elements. In step 104, the hydrophobic silica is coated with a pigmented water-based backcoating, preferably white. At step 108 the layer of adhesive is applied to the backcoating and in step 110 a release 10 liner is laminated to the adhesive. Again, such liner is used to prevent the adhesive from inadvertently sticking to a surface before it is intended to be used.

Since the present film is primarily to be used indoors, additional overlays or other ultraviolet 15 inhibitors which help prevent deterioration of outdoor retroreflective sheeting may not be necessary, further reducing the processing cost.

FIG. 9 discloses a sample microsphere beaded type sheet material 130 employing the present invention. The 20 beaded sheeting 130 may be of the type produced by 3M Corporation and sold under the trademark Scotchlitter. It is believed such material is made in accordance with various 3M patents such as Nos. 2,407,680 and 4,511,210. In this embodiment the sheeting comprises a layer of 25 monosphere beads 135 and a transparent layer of resin below which may be a specially reflecting surface 136. The phosphorescent pigment 134 may be employed in an overlay over the beads, or in the binder layer 137 in which the beads are embedded. In the case of so-called 30 high intensity beaded sheets, the phosphorescent pigment may be incorporated into the cell walls. A layer of adhesive 138 and a release liner 139 also may be used.

In the alternative embodiment illustrated in FIG.

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10, the sheet 140 is again formed of a transparent flexible film 142 of thickness ranging from about 0.006 inches to about 0.008 inches that has retroreflective cube corner elements 144 formed on the reverse side 5 thereof. This embodiment, however, contains a second, photoluminescent film 146 having thickness in the range of from about 0.010 to about 0.020 inches, which is attached to the reverse side of the transparent retroreflective sheet by heat sealing, sonic welding or 10 other process known in the art. Preferably, the photoluminescent film 146 contains the photoluminescent pigment described above.

The attachment of the photoluminescent film to the transparent film is according to a pre-selected pattern. 15 Preferably, the pattern is created in the photoluminescent film at the time of heat sealing or sonic welding as shown in FIG. 10. Alternatively, the pattern can be created in the transparent film before attachment to the photoluminescent film by creation of a 20 pattern in the embossing tool which forms the cube corner micro-prisms.

At least part of the photoluminescent film is spaced from the cube corner micro-prisms on the reverse side of the retroreflective sheet to form air cells 148 25 therebetween, thereby maintaining the retroreflective quality. There is no air between the retroreflective film and photoluminescent film at the points where the heat sealing or sonic welding 150 attachment has been made to the reverse side of the retroreflective layer. 30 Moreover, the cube corners will be deformed or destroyed by the heat sealing and sonic welding processes.

The second, photoluminescent film has attached to its backside a white adhesive layer 152 which can be

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either laminated to or coated directly on the film. A release liner 153 covers the adhesive to prevent contact of the adhesive with any surface until the sheeting is to be applied. The release liner can be removed from the 5 sheeting without removing the white adhesive, as is known in the art.

FIG. 11 shows yet another alternative embodiment 154 of the inventive photoluminescent retroreflective sheeting. Again, this embodiment contains a transparent 10 flexible film 156 of about 0.006 inches to about 0.008 inches in thickness, and has embossed on its reverse side a series of cube corner micro-prisms 158 producing the retroreflective characteristics discussed above.

The reverse side of the retroreflective film has 15 attached to it a flexible thermoplastic film 160 composed of two distinct layers. The first layer 162 contains photoluminescent pigment and the second layer 164 is an opaque white layer. The thickness of this two layer film is in the range of from about 0.015 inches to about 0.030 20 inches. Such films are commercially available as "photoluminescent vinyl tape" sold by Hanovia of Newark, New Jersey (as part of its Escape Route System), and as Lumiluxr sold by the Fine Chemicals Division of Hoechst Celanese, Charlotte, North Carolina.

25 This two layered second thermoplastic film is attached preferably in a pre-selected pattern to the cube corner containing reverse side of the retroreflective sheet by heat sealing, sonic welding or similar process known in the art 166. Alternatively, the 30 pattern can be created in the transparent retroreflective sheet before heat sealing or sonic welding to the second film. The second film is spaced from the retroreflective micro-prisms where it is not heat sealed, sonic welded or

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otherwise attached, to form air cells 168 therebetween. The retroreflective quality of the top sheet is preserved where the air cells have been created.

An adhesive layer 170 is either laminated to or 5 coated directly on the second two-layer film. The adhesive has a release liner 172 reversibly attached to its reverse side. The release liner prevents inadvertent contact of the adhesive with any surface until the sheeting is to be applied. The release liner 172 may be 10 removed from the sheet without removing or otherwise staying attached to the adhesive of the adhesive layer 170.

FIG. 12 shows a schematic drawing of the process of making the embodiments shown in FIGS. 10 and 11. The 15 initial step, shown at the top of FIG. 12, is the extrusion of a flexible transparent film 174 having thickness of approximately 0.006 inches to about 0.008 inches. After this film is extruded, cube corner prisms or micro-prisms are formed 176 on its reverse side, 20 preferably by embossing. The formation of the cube corner prisms or micro-prisms transforms the transparent material into a retroreflective sheet capable of reflecting incident light.

The extrusion of the flexible film and the formation 25 of the cube corners on its reverse side is followed by application of the second film 178 which contains the photoluminescent pigment. This film is attached in a pre-selected pattern to the reverse side of the first, retroreflective sheet through heat sealing, sonic welding 30 or other similar means. The photoluminescent film is spaced from the cube corner micro-prisms on the reverse side of the retroreflective sheet, except where it is attached by heat sealing or sonic welding. This

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photoluminescent film is about 0.010 inches to about 0.020 inches in thickness and has attached to its reverse side in the next process step 180 a white adhesive layer. This adhesive layer is capable of attaching the sheeting 5 to a desired surface.

A release liner is applied to the adhesive layer in the following step 182 to prevent contact of the adhesive with any surface until the sheeting is desired to be applied. The release liner may be removed from the 10 adhesive layer without removing the adhesive layer, leaving the adhesive intact so that it will be present when the sheeting comes into contact with the desired application surface.

The above-described process will result in the sheet 15 illustrated in FIG. 10. A variation of this process will result in the embodiment shown in FIG. 11. This variation is made by the process described above except for steps 178 and 180. For step 178 a second, thermoplastic film which has a thickness of approximately 20 0.015 inches to about 0.030 inches is applied instead of the photoluminescent film described for step 178 above. This second film contains a top photoluminescent first layer containing a photoluminescent pigment, followed by a second, white opaque layer. Because of the presence of 25 the opaque white layer in the second film applied in step 178, the adhesive layer applied in step 180 need not be white. All the remaining details of the process steps to produce the embodiment of FIG. 11 are the same as described above to produce the embodiment in FIG. 10.

30 It will be appreciated from the foregoing that the present invention provides significant advantages for safety purposes in that dual functions can be obtained while utilizing sheeting having a high degree of

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retroreflectivity and photoluminescence while minimizing the amount of material required for each such purpose.

While the invention has been described in connection with a preferred embodiment, it is not intended to limit 5 the scope of the invention to the particular form set forth, but, on the contrary, it is intended to cover such alternatives, modifications, and equivalents as may be included within the spirit and scope of the invention as defined by the appended claims.

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CLAIMS

1. Phosphorescent retroreflective sheeting comprising:

5 a transparent film having a front face and a reverse face, and having cube corner retroreflectors formed on the reverse face thereof for retroreflecting light incident on the front face of the film;

10 a phosphorescent film attached to the reverse face of the transparent film in a pre-selected pattern, such that at least parts of the phosphorescent film are spaced from the transparent film to form air cells therebetween, said phosphorescence being visible through said retroreflectors from the front face of said transparent film; and

15 a white adhesive secured to the phosphorescent film for attaching the sheeting to a surface.

2. The sheeting of claim 1, further comprising a release liner attached to the adhesive to prevent inadvertent contact of the adhesive with another surface.

20 3. The sheeting of claim 1, wherein the phosphorescent film is attached to the transparent film by a means selected from the group consisting of heat sealing and sonic welding.

25 4. The sheeting of claim 1, wherein the retroreflectors are formed in a pre-selected pattern on the reverse face of the transparent film.

5. The sheeting of claim 1, wherein the phosphorescent film is from about 0.010 inches to about

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0.020 inches thick.

6. The sheeting of claim 1 wherein the adhesive is applied to the phosphorescent film by means selected from the group consisting of lamination and direct coating.

5 7. Phosphorescent retroreflective sheeting comprising:

a transparent film having a front face and a reverse face, and having cube corner retroreflectors embossed on the reverse face thereof for retroreflecting light  
10 incident on front face of the film;

a phosphorescent film of thickness of from about 0.010 inches to about 0.020 inches, attached by means selected from the group consisting of heat sealing and sonic welding to the reverse face of the transparent film  
15 in a pre-selected pattern, such that the phosphorescent film is at least partially spaced from the transparent film to form air cells therebetween, said phosphorescence being visible through said retroreflectors from the front face of said transparent film;

20 a white adhesive secured to the phosphorescent film for attaching the sheeting to a surface; and,

a release liner attached to the adhesive to prevent inadvertent contact of the adhesive with a surface.

8. Photoluminescent retroreflective sheeting  
25 comprising:

a transparent film having cube corner retroreflectors formed on the reverse side thereof for retroreflecting light incident on the film;

30 a second film attached to the reverse side of the transparent film, the second film being at least

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partially spaced from the transparent film to form air cells therebetween, the second film having first layer containing photoluminescent pigment and second layer being opaque white; and,

5 an adhesive secured to the second film for attaching the sheeting to a surface.

9. The sheeting of claim 9 further comprising a release liner attached to the adhesive to prevent inadvertent contact of the adhesive with a surface.

10 10. The sheeting of claim 9, wherein the second film is attached to the transparent film in a pre-selected pattern.

11. The sheeting of claim 11, wherein the second film is attached to the transparent film by a means 15 selected from the group consisting of heat sealing and sonic welding.

12. The sheeting of claim 9, wherein the retroreflectors are formed in a pre-selected pattern on the transparent film.

20 13. The sheeting of claim 9 wherein the thermoplastic film is from about 0.015 inches to about 0.030 inches thick.

14. The sheeting of claim 9 wherein the adhesive is applied to the thermoplastic film by means selected from 25 the group consisting of lamination and direct coating.

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15. Photoluminescent retroreflective sheeting comprising:

a transparent film having cube corner retroreflectors embossed on the reverse side thereof for 5 retroreflecting light incident on the film;

a flexible thermoplastic film from about 0.015 inches to about 0.030 inches thick attached to the reverse side of the transparent film in a pre-selected pattern by a means selected from the group of heat 10 sealing and sonic welding, the thermoplastic film being at least partially spaced from the transparent film to form air cells therebetween, the thermoplastic film having first layer containing photoluminescent pigment and second layer being opaque white;

15 an adhesive applied by means selected from the group consisting of lamination and direct coating to the photoluminescent film for attaching the sheeting to a surface; and,

20 a release liner attached to the adhesive to prevent inadvertent contact of the adhesive with a surface.

16. A method of forming photoluminescent retroreflective sheeting comprising the steps of:

25 forming cube corner retroreflectors on the reverse side of a transparent film to form a retroreflective layer that will produce retroreflective illumination upon receiving incident light;

securing a photoluminescent film to the reverse side of the transparent film, at least part of the photoluminescent film being spaced from the transparent 30 film to form air cells therebetween;

applying a white adhesive layer to the

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photoluminescent film layer for attaching the sheeting to a surface; and,

removably securing a release liner to the adhesive layer to prevent inadvertent contact of the adhesive 5 layer with a surface.

17. The method of claim 17 wherein the cube corner retroreflectors are embossed on the transparent film in a predetermined pattern.

18. The method of claim 17 wherein the 10 photoluminescent film is secured to the transparent film in a pre-selected pattern.

19. The method of claim 19 wherein the photoluminescent film is secured by a method selected from the group consisting of heat sealing and sonic 15 welding.

20. The method of claim 20 wherein the photoluminescent layer is from about 0.010 inches to about 0.020 inches thick.

21. The method of claim 21 wherein the adhesive is 20 applied to the photoluminescent film by the method selected from the group consisting of lamination and direct coating.

22. A method of forming photoluminescent retroreflective sheeting comprising the steps of:

25 forming cube corner retroreflectors on the reverse side of a transparent film to form a retroreflective layer that will produce retroreflective illumination upon

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receiving incident light on the front face of the film;  
securing a second film to the reverse side of the  
transparent film with at least part of the second film  
being spaced from the transparent film to form air cells  
5 therebetween, the second film having a first  
photoluminescent layer and a second opaque white layer;  
applying an adhesive layer to the second film for  
attaching the sheeting to a surface; and  
removably securing a release liner to the adhesive  
10 layer to prevent inadvertent contact of the adhesive  
layer with a surface.

23. The method of claim 23 wherein the cube corner  
retroreflectors are embossed on the transparent film in  
a predetermined pattern.

15 24. The method of claim 23 wherein the second film  
is secured to the transparent film in a pre-selected  
pattern.

25. The method of claim 25 wherein the second film  
is secured by a method selected from the group consisting  
20 of heat sealing and sonic welding.

26. The method of claim 26 wherein the second film  
is from about 0.015 inches to about 0.030 inches thick.

27. The method of claim 27 wherein the adhesive is  
applied to the second film by the method selected from  
25 the group consisting of lamination and direct coating.

## AMENDED CLAIMS

[received by the International Bureau on 18 July 1994 (18.07.94);  
original claim 10 cancelled; original claims 8,9,11-15,17-21,23-27 amended;  
original claims 11-27 renumbered as claims 10-26;  
remaining claims unchanged (5 pages)]

0.020 inches thick.

6. The sheeting of claim 1 wherein the adhesive is applied to the phosphorescent film by means selected from the group consisting of lamination and direct coating.

5 7. Phosphorescent retroreflective sheeting comprising:

a transparent film having a front face and a reverse face, and having cube corner retroreflectors embossed on the reverse face thereof for retroreflecting light 10 incident on front face of the film;

a phosphorescent film of thickness of from about 0.010 inches to about 0.020 inches, attached by means selected from the group consisting of heat sealing and sonic welding to the reverse face of the transparent film 15 in a pre-selected pattern, such that the phosphorescent film is at least partially spaced from the transparent film to form air cells therebetween, said phosphorescence being visible through said retroreflectors from the front face of said transparent film;

20 a white adhesive secured to the phosphorescent film for attaching the sheeting to a surface; and,

a release liner attached to the adhesive to prevent inadvertent contact of the adhesive with a surface.

8. Phosphorescent retroreflective sheeting 25 comprising:

a transparent film having a front face and a reverse face, and having cube corner retroreflectors formed on the reverse face thereof for retroreflecting light incident on the front face of the film;

30 a second film attached to the reverse face of

the transparent film in a pre-selected pattern, such that at least parts of the second film are spaced from the transparent film to form air cells therebetween, the second film comprising a first layer containing a 5 phosphorescent pigment and a second layer that is opaque white, said phosphorescence being visible through said retroreflectors from the front face of the transparent film; and,

an adhesive secured to the second film for 10 attaching the sheeting to a surface.

9. The sheeting of claim 8 further comprising a release liner attached to the adhesive to prevent inadvertent contact of the adhesive with a surface.

10. The sheeting of claim 8, wherein the second 15 film is attached to the transparent film by a means selected from the group consisting of heat sealing and sonic welding.

11. The sheeting of claim 8, wherein the retroreflectors are formed in a pre-selected pattern on 20 the reverse side of the transparent film.

12. The sheeting of claim 8 wherein the second film is from about 0.015 inches to about 0.030 inches thick.

13. The sheeting of claim 8 wherein the adhesive is applied to the second film by means selected from the 25 group consisting of lamination and direct coating.

14. Photoluminescent retroreflective sheeting comprising:

a transparent film having cube corner retroreflectors embossed on the reverse side thereof for 5 retroreflecting light incident on the film;

10 a flexible thermoplastic film from about 0.015 inches to about 0.030 inches thick attached to the reverse side of the transparent film in a pre-selected pattern by a means selected from the group of heat sealing and sonic welding, the thermoplastic film being at least partially spaced from the transparent film to form air cells therebetween, the thermoplastic film having first layer containing photoluminescent pigment and second layer being opaque white;

15 an adhesive applied by means selected from the group consisting of lamination and direct coating to the photoluminescent film for attaching the sheeting to a surface; and,

20 a release liner attached to the adhesive to prevent inadvertent contact of the adhesive with a surface.

15. A method of forming photoluminescent retroreflective sheeting comprising the steps of:

25 forming cube corner retroreflectors on the reverse side of a transparent film to form a retroreflective layer that will produce retroreflective illumination upon receiving incident light;

30 securing a photoluminescent film to the reverse side of the transparent film, at least part of the photoluminescent film being spaced from the transparent film to form air cells therebetween;

applying a white adhesive layer to the

photoluminescent film layer for attaching the sheeting to a surface; and,

removably securing a release liner to the adhesive layer to prevent inadvertent contact of the adhesive 5 layer with a surface.

16. The method of claim 15 wherein the cube corner retroreflectors are embossed on the transparent film in a predetermined pattern.

17. The method of claim 15 wherein the 10 photoluminescent film is secured to the transparent film in a pre-selected pattern.

18. The method of claim 17 wherein the photoluminescent film is secured by a method selected from the group consisting of heat sealing and sonic 15 welding.

19. The method of claim 18 wherein the photoluminescent layer is from about 0.010 inches to about 0.020 inches thick.

20. The method of claim 19 wherein the adhesive is 20 applied to the photoluminescent film by the method selected from the group consisting of lamination and direct coating.

21. A method of forming photoluminescent retroreflective sheeting comprising the steps of:

25 forming cube corner retroreflectors on the reverse side of a transparent film to form a retroreflective layer that will produce retroreflective illumination upon

receiving incident light on the front face of the film;  
securing a second film to the reverse side of the transparent film with at least part of the second film being spaced from the transparent film to form air cells  
5 therebetween, the second film having a first photoluminescent layer and a second opaque white layer;  
applying an adhesive layer to the second film for attaching the sheeting to a surface; and  
removably securing a release liner to the adhesive  
10 layer to prevent inadvertent contact of the adhesive layer with a surface.

22. The method of claim 21 wherein the cube corner retroreflectors are embossed on the transparent film in a predetermined pattern.

15 23. The method of claim 21 wherein the second film is secured to the transparent film in a pre-selected pattern.

24. The method of claim 23 wherein the second film is secured by a method selected from the group consisting  
20 of heat sealing and sonic welding.

25. The method of claim 24 wherein the second film is from about 0.015 inches to about 0.030 inches thick.

26. The method of claim 25 wherein the adhesive is applied to the second film by the method selected from  
25 the group consisting of lamination and direct coating.

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FIG. 1

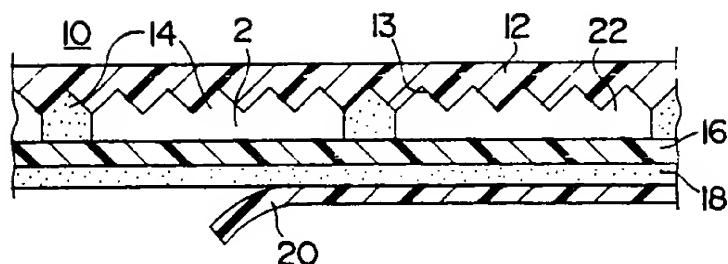


FIG. 2

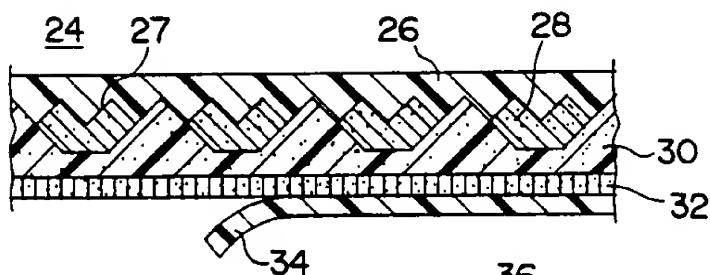


FIG. 3

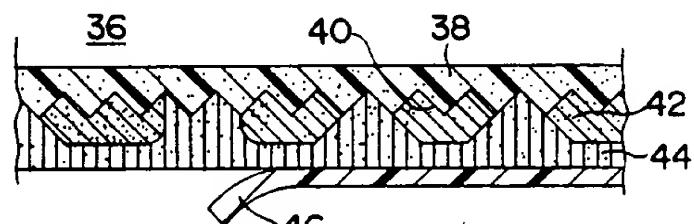
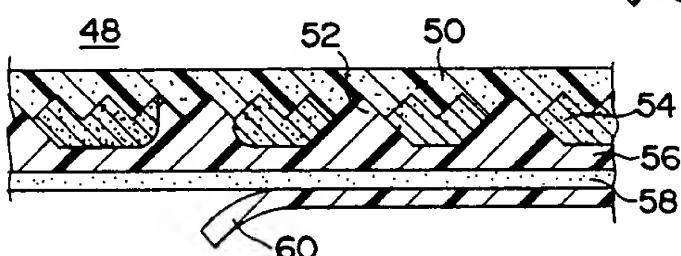


FIG. 4



62  
FORM A TRANSPARENT FLEXIBLE FILM WITH CUBE CORNERS ON THE REVERSE SIDE

68  
SCREEN PRINT A CLEAR ADHESIVE CONTAINING A PHOSPHORESCENT PIGMENT IN A PATTERN ON THE CUBE CORNERS

70  
CURE THE ADHESIVE

72  
LAMINATE FILM TO THE ADHESIVE TO FORM AIR CELLS

74  
ADD AN ADHESIVE LAYER TO THE FILM

76  
LAMINATE A RELEASE LAYER TO THE ADHESIVE LAYER

FIG. 5

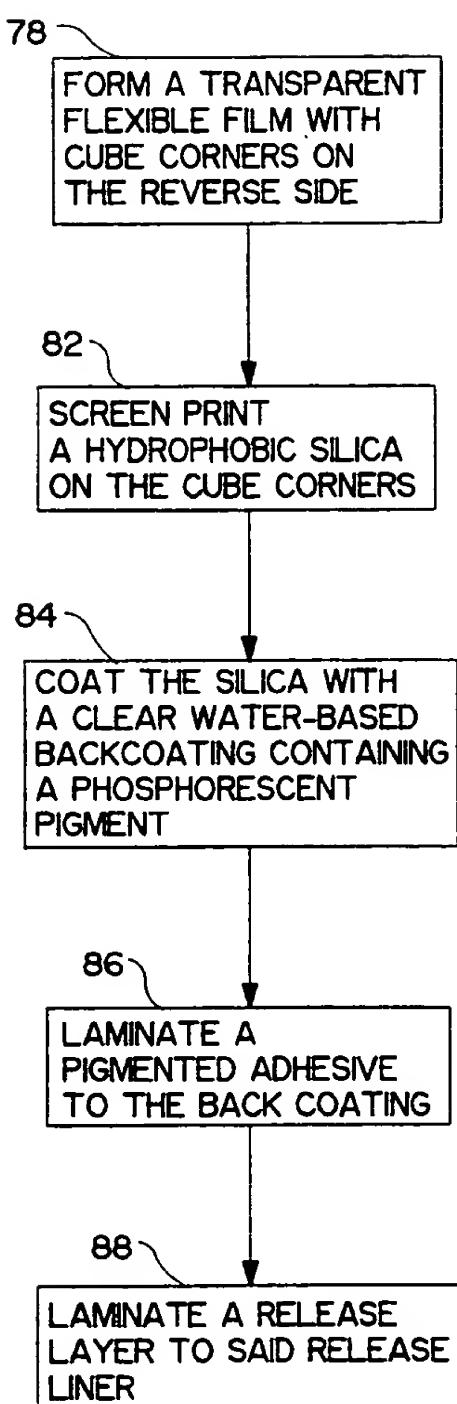


FIG. 6

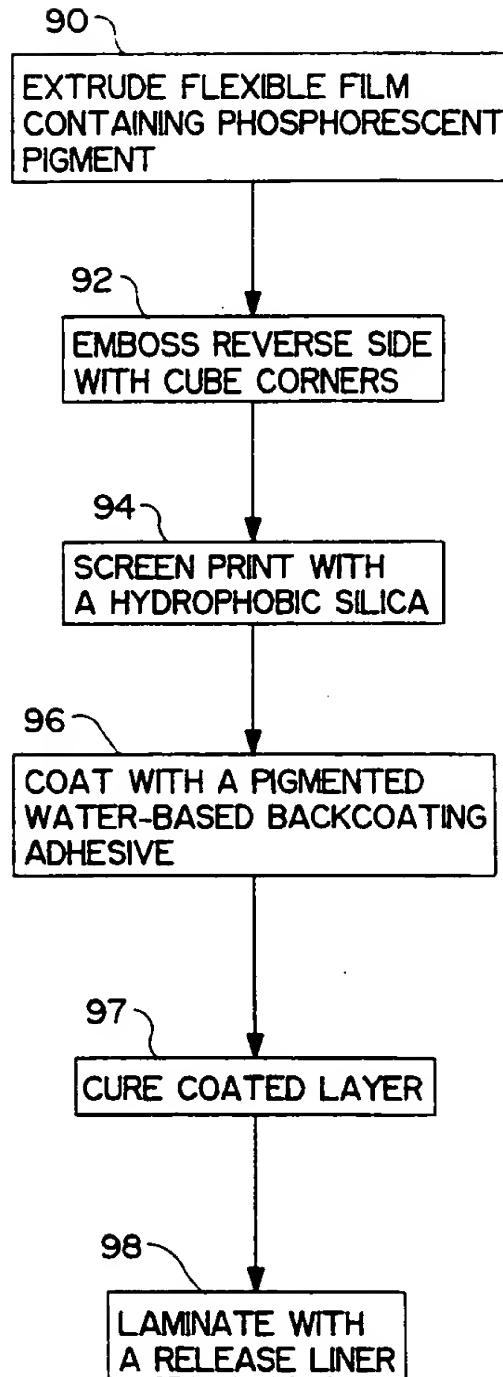


FIG. 7

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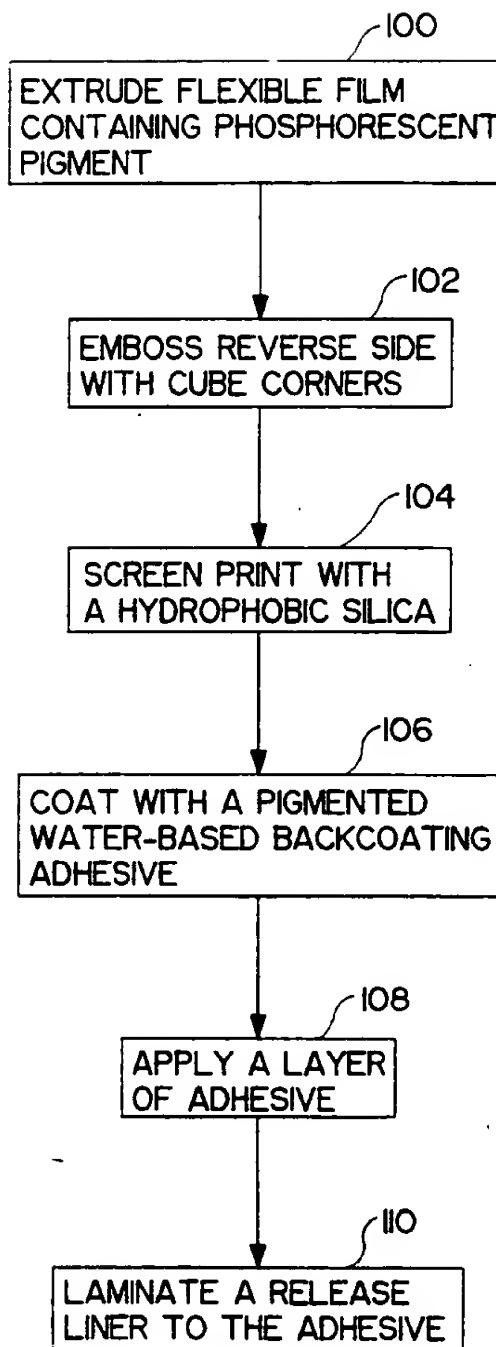


FIG. 8

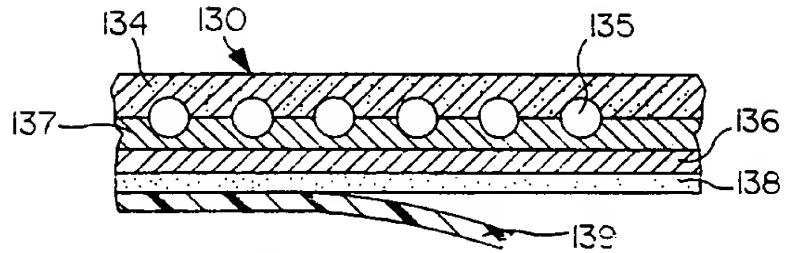


FIG. 9

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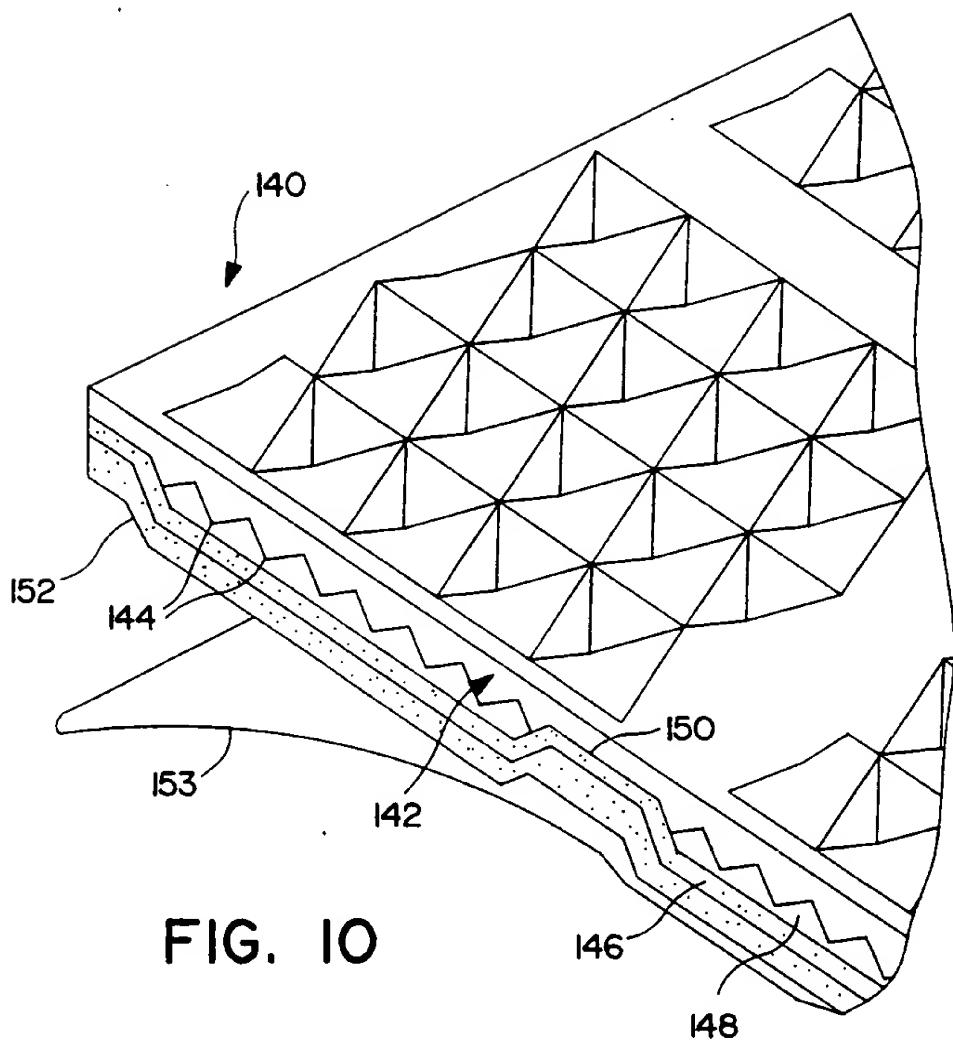
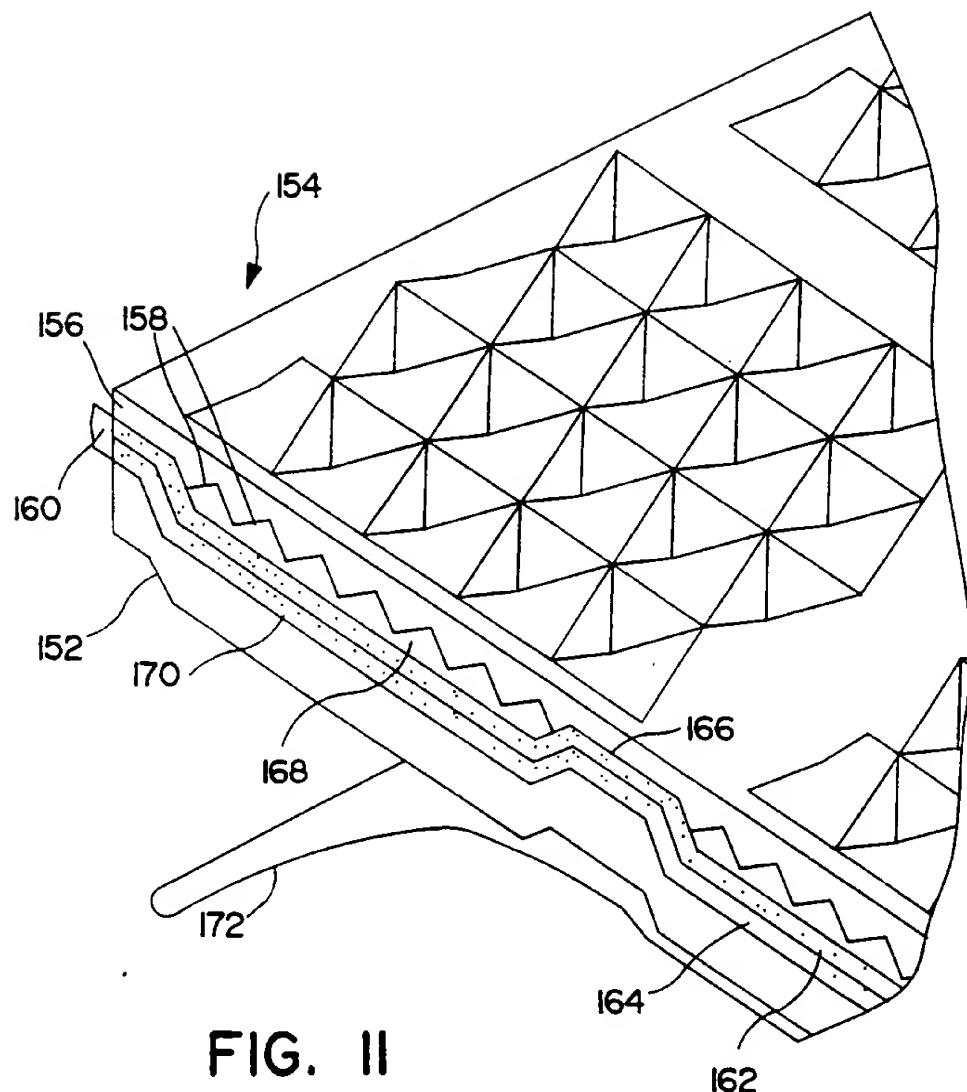


FIG. 10

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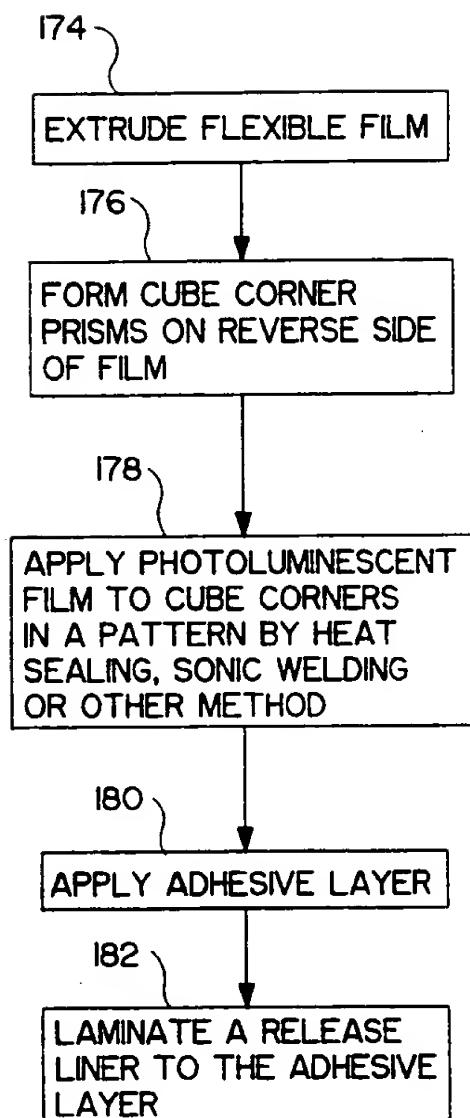


FIG. 12

## INTERNATIONAL SEARCH REPORT

In. application No.

PCT/US94/01283

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(S) :Please See Extra Sheet.

US CL :Please See Extra Sheet.

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 428/40, 323, 352, 354, 913; 156/67, 73.1, 289; 359/527, 528, 529, 530

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS search: terms: phosphoresc?, fluorescen?, photoluminescen?, luminesc?

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 4,618,518 (PRICONE et al.) 21 OCTOBER 1986, see Figs. 1-4.	1-27
Y	US, A, 3,830,682 (ROWLAND) 20 AUGUST 1974, see Figs. 1 & 3.	1-27
Y	US, A, 4,546,042 (QUON) 08 OCTOBER 1985, see column 2, line 28-column 3, line 3.	1-27
A	US, A, 3,802,944 (TUNG) 09 APRIL 1974, see Fig. 1 and column 1, lines 31-45.	1-27

Further documents are listed in the continuation of Box C.  See patent family annex.

•	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
*A*	document defining the general state of the art which is not considered to be part of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
*E*	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
*L*	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Z"	document member of the same patent family
*O*	document referring to an oral disclosure, use, exhibition or other means		
*P*	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search	Date of mailing of the international search report
28 APRIL 1994	MAY 10 1994

Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer TERREL MORRIS Telephone No. (703) 308-2351
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Form PCT/ISA/210 (second sheet)(July 1992)\*

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US94/01283

## A. CLASSIFICATION OF SUBJECT MATTER:

IPC (S):

A61F 13/02; E04F 15/16; B32B 5/16, 7/12, 15/04, 31/16; B44F 1/00; C09K 11/00; G02B 5/124, 5/128, 5/136

## A. CLASSIFICATION OF SUBJECT MATTER:

US CL :

428/40, 323, 352, 354, 913; 156/67, 73.1, 289; 359/527, 528, 529, 530